

Proceedings of the Iowa Academy of Science

Volume 4 | Annual Issue

Article 8

1896

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Recommended Citation

Leonard, A. G. (1896) "Natural Gas in the Drift of Iowa," *Proceedings of the Iowa Academy of Science*, 4(1), 41-47.

Available at: <https://scholarworks.uni.edu/pias/vol4/iss1/8>

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NATURAL GAS IN THE DRIFT OF IOWA.

BY A. G. LEONARD.

The finding of natural gas in the Pleistocene deposits of the state has been noted from time to time during the past decade. The first mention of its occurrence, as far as known, appeared in the report of the state mine inspector* for the years 1886 and 1887.

A brief account is therein given of its discovery at Herndon, Guthrie county, in 1886, while boring a hole for water. Six wells are reported as yielding a good flow of gas, which was utilized for cooking and heating purposes. The presence of gas at Herndon is also mentioned by McGee in the Eleventh Annual Report of the United States Geological Survey.† In the proceedings of the Iowa Academy of Sciences for 1890-1891 Mr. F. M. Witter‡ reports the discovery of natural gas near Letts, Louisa county. Seven wells sunk for water yielded it, and the gas from one furnished fuel and light for four families. Its probable source is stated to be from the vegetable matter buried in the drift.

R. Ellsworth Call in the Monthly Review of the Iowa Weather and Crop Service for November, 1892,§ reports that there are many instances of the discovery of natural gas in the drift of the state while exploring for coal or for artesian waters. The wells at Herndon and Letts are noted as are also those at Dawson, in Dallas county.

In all cases the gas is thought to have come from the vegetable debris of the glacial deposits.

Among the other localities where this natural fuel has been found may be mentioned one about seven miles northeast of Des Moines and another not far from Stanhope, in Hamilton county. For several years gas from the well at the latter place has been utilized for fuel.

*Report state mine inspector, 1887, pp. 169-170.

†Eleventh Ann. Rept., 1889-1890, part I, p. 595.

‡Iowa Acad. Sci., vol. I, part II, pp. 68-70.

§Monthly Rev. Iowa Weather and Crop Serv., vol. III, Nov., 1892, p. 6-7.

From the above it will be seen that the occurrence of natural gas in the glacial deposits of the state is not an uncommon event and that a number of different localities have yielded it in small amounts.

Before taking up the subject of the source and origin of the natural gas it will be well to describe more in detail some of the localities mentioned above, in order that the conditions under which the gas is found may be clearly in mind. Only after such a careful review of the facts connected with the various occurrences is it possible to form an opinion as to the probable source. A comparison of the Iowa localities with those of other states will also prove helpful in this connection.

The Herndon wells were the first in the state, so far as known, to yield gas in any considerable amount. Its discovery is thus described in the mine inspector's report already referred to: In the month of October, 1886, Mr. G. Gardner was boring a hole for water and had reached a depth of about 120 feet. Work had been stopped for the night and the family was at supper when suddenly a loud noise was heard like that made by steam escaping from a boiler, and on going out to the well it was found discharging large quantities of gas, sand and gravel. This first well was not used on account of the difficulty experienced in getting it tubed so as to shut out the sand. A second was abandoned for the same reason, but the third, put down by Mr. H. C. Booth, was more successful. The gas was conducted into the house and used for heating and cooking purposes. Six wells have been bored here and a good strong flow obtained in all of them. In two of these the flow still continues but the others have become choked up with sand. The depth of the wells varies from 120 to 140 feet. The gas is found in a layer of sand and above this the following beds occur:

	FEET.
Black loam	6
Yellow clay	6
Blue clay	108

One well at this locality is reported to have reached a depth of over 219 feet and went a considerable distance into the coal measures, but it yielded no gas. Another well, which for a time had a good flow of gas, was located near the town of Yale, five miles south of Herndon.

The only direct evidence of any considerable accumulations of vegetable material in the drift of this region is furnished by

the record of an old water well near Yale, where a forest bed some three feet in thickness was passed through. It was overlaid by forty-two feet of yellow, blue and red clay and beneath was four or five feet of blue clay. Below the latter there is from two to ten feet of sand. The gas at Herndon is found in a layer of sand at the base of the drift and probably directly overlying the coal measure shales.

During the past summer the wells near Dawson were visited and a few additional facts secured concerning them. Dawson is located near the northern border of Dallas county and about eight miles east of Herndon. The wells are three-quarters of a mile south of town and the gas occurs under much the same conditions as at the locality already mentioned. Five holes have been drilled here, one being put down in 1888 and the other four in 1891. They have a depth of from 110 to 115 feet, passing through the drift clay into a bed of sand and gravel. The gas is found in the gravel layer below a compact blue clay. A coal shaft just east of Dawson shows sixty-four feet of this blue clay. During the past summer the first well, bored eight years ago, was tested to find the pressure, the result being that this was ascertained to be 24 to 25 pounds to the square inch. The gas burned with a flame 15 to 20 feet high. It was piped to town, and for a time supplied one of the houses with fuel. It was also used in the kilns of a brick plant a short distance east of the station. Three of the wells still have a good flow but are no longer used.

In this connection mention should perhaps be made of the gas found in considerable quantity in the water supply of Perry, six miles east of Dawson. Perry secures its supply from four wells located in the southern part of town. These wells have a depth of 115 feet. Gravel is struck 70 feet below the surface and the lower 45 feet is through this material. The water for a time came to the surface and overflowed, but after a number of wells were sunk and it had been pumped from the city wells the head was lowered, and now the water rises only to within 5 or 6 feet of the surface. The amount of gas in the water is so great that Mr. J. W. Rodefer has for some time been experimenting for the purpose of extracting it for use in heating and lighting. He has succeeded in doing this on a comparatively small scale, and the gas thus separated is utilized to furnish fuel and light to his office. Can it be extracted by a sufficiently inexpensive method, and in large enough quantity,

this natural gas contained in its water supply may yet furnish Perry with a convenient fuel.

In the case of the wells near Letts, Louisa county, the conditions appear to be slightly different. They have a depth ranging from 90 to 125 feet, but do not reach the base of the drift, since in a number of instances the rock in this region has not been struck at 280 feet below the surface. "At a depth of from 6 to 25 feet below the gas a good, constant supply of water is obtained. It seems to be very easy to shut off the gas by the rapid sinking of the casing in a sort of blue clay with some sand, in which the gas is thought to be stored. The clay seems to form a tube as the drill and casing descend, and this prevents the gas from getting into the well unless it is given a little time at the right place. The country for miles around is full of wells which are all believed to be sunk to the water below the gas, without discovering the latter for reasons given above." From the foregoing statements it is apparent that the gas at this locality does not occur in a well defined sand bed, but is distributed through the upper portion of the Pleistocene deposits, being usually found at a depth of about 100 feet. There seems to be abundant evidence of the presence of extensive accumulations of vegetable material in the drift of this region.

But Iowa is not the only state where natural gas is found in the surface deposits, for it occurs also in the drift of Ohio, Indiana and Illinois. Its occurrence in Ohio is mentioned by Orton.* On the southern margin of the drift of that state and for twenty to forty miles back from its border there are in many parts of the state considerable accumulations of vegetable matter covered by later deposits of the drift period. Wells dug into these deposits often strike quite extensive accumulations of one or the other of the two gases given off by the decomposition of this buried vegetation, namely, carbon dioxide and marsh gas. Sometimes carbon dioxide, or carbonic acid gas as it is commonly called, is found in all the wells of the neighborhood and no water well can be completed on account of its presence. It is not an uncommon thing for well diggers to lose their lives from this deadly "choke damp."

Calvin has noted several instances in Iowa where this gas escaped with considerable force from holes bored for water.

*Geol. Surv. of Ohio, vol. VI, pp. 772-775.

Much more frequently marsh gas is struck in the vegetable deposits (of Ohio) and sometimes escapes in large volume and with great force when first released. It not infrequently gives rise to a small but persistent supply. Gas wells are of common occurrence in all the border areas above mentioned.

In Illinois natural gas in the drift has been found in commercially valuable quantities at Bloomington, Kankakee, Mendota, and other points.

The reports of the Indiana survey also contain accounts of the discovery of gas in the superficial deposits of that state.

From what has been said above it will be seen that it is by no means an uncommon thing to find gas in the Pleistocene deposits. It has been discovered at a number of different points in at least four states and doubtless there are unrecorded occurrences in other parts of the country.

We are now prepared to consider the question as to the source of this natural gas and later its origin.

There are two possible sources of the gas found in the drift. (1) It may have been derived from the underlying rock and the drift then serve simply as a reservoir for its accumulation and storage, or (2) it may have been derived from the vegetable accumulations of the drift and thus have its source in the Pleistocene deposits where it is now found. The latter source is doubtless much the more common and in most instances there is little doubt that the gas has been derived from the decomposition of the vegetable remains in the drift. But examples of the drift serving as a reservoir only, are occasionally found. Thus, Orton mentions several such instances in Ohio and it is possible, though hardly probable, that at Herndon and Dawson the gas has been derived from the underlying coal measures shales.

That it may have such a source the gas-bearing rocks must be overlaid by porous beds of drift. Then during the long periods since they have had this relation the porous beds have become charged with gas when there were suitable conditions of level. As we have already seen the arrangement of the beds at Herndon and Dawson are such that it is possible that the gas might be derived from the rocks underlying the drift sheet. At both of these localities the gas occurs in a stratum of sand and gravel at the base of the drift and apparently directly overlying the coal measures. As already stated the wells have a depth

of from 110 to 140 feet. Nowhere in this immediate neighborhood is the drift known to have a greater depth than this. At Dawson a coal shaft shows the superficial deposits to be eighty feet thick at that point. At Angus, a few miles northeast of Dawson, there is a thickness of fifty to 100 feet and in southern Greene county borings show between sixty and seventy feet of drift. There seems to be considerable evidence, therefore, that the gravel is at the base of glacial deposits and that it rests directly on the coal measure shales. In this case it would be possible that the gas, originating in these black carbonaceous shales, may have passed up into and accumulated in the gravel and sand beds above.

But it seems much more probable that the gas at Herndon and Dawson has its source in the vegetable accumulations of the drift, as is undoubtedly true for the gas at Letts.

It is not necessary to suppose that it has been formed directly in the place where it is now found. It may have originated from the decomposition of vegetable material some considerable distance off and later have diffused itself laterally through the gravel beds until reaching a place favorable for its accumulation.

There is another interesting fact concerning the distribution of these gas wells. They are found not far from the border of the upper drift sheet of the region. Thus, for example, at Dawson and Herndon the wells are only a few miles back from the edge of the Wisconsin lobe and at Letts the Illinois ice seems to have extended but a short distance in the west. Orton mentions the same fact concerning the distribution of wells in Ohio, where as already stated, they are found along the border of the glacial deposits or back twenty to forty miles.

The most favorable conditions for the preservation of forest beds and like accumulations of vegetable material would seem to be near the edge of the ice, where it was the thinnest, and where, during its advance, there would have been less disturbance of the materials beneath. During its advance only a comparatively few miles of the ice sheet would pass over the drift near its border, while back 50 or 75 miles the ice would doubtless be considerably thicker and a vastly greater amount of ice would pass over the surface, and as a result the underlying deposits would be more disturbed. The forest bed, if present, might be carried away or mingled with the clay of the drift.

Concerning the origin of natural gas little need be said. It is now generally admitted by all geologists and most chemists

that the various bitumens, including natural gas, are genetically connected with and are closely allied to marsh gas, and that they are produced by the natural decomposition of organic tissue. Natural gas closely resembles in composition the inflammable marsh gas which is often observed coming from the muddy bottoms of stagnant ponds. The following analysis, giving the mean results of seven analyses made for the United States Geological survey by Prof. C. C. Haward, will show the composition of natural gas:

Marsh gas.....	93.36
Nitrogen.....	3.28
Hydrogen.....	1.76
Carbon monoxide.....	.53
Oxygen.....	.29
Olefiant gas.....	.28
Carbon dioxide.....	.25
Hydrogen sulphide.....	.18
Total.....	100.03

Marsh gas, the principal constituent, is a simple compound of carbon and hydrogen in the proportions of 75 per cent of the former to 25 per cent of the latter.

The natural gas of the Pleistocene deposits of Iowa is then simply the product of the decomposition of the vegetable remains buried in the drift.

RESULTS OF RECENT GEOLOGICAL WORK IN MADISON COUNTY.

BY J. L. TILTON.

OUTLINE.

1. The geological formations of the county.
2. The distribution of the alluvium, loess and drift.
3. The relation of present drainage to preglacial drainage.
4. Terraces.
5. The areas occupied by the Des Moines and Missourian stages of the coal measures.
6. The transition from the Des Moines to the Missourian stage.

It is intended in this paper to state briefly some of the geological features of Madison county as observed during the